APPENDIX D

TYPICAL SPILLWAY OPTIMIZATION STUDY

(Red River, Louisiana)

1. SCOPE. This appendix summarizes the optimization studies for selection of spillway components. The goal is to select the optimum number of spillway gates and length of overflow dam. The spillway alternatives studied are tabulated in Table D-3.

2. DESIGN GUIDANCE FOR NAVIGATION DAM STRUCTURES.

a. Plans with Gates Only (No Overflow Dam). These plans provide a T-wall dam extending from last gate pier to nonoverflow embankment dam. Length of T-wall dam is governed by excavation slopes for last spillway gate bay and by location of the riverward end of the nonoverflow embankment dam. The landward end of the T-wall dam must be embedded in the riverward end of the nonoverflow embankment dam. The tops of abutments and T-wall dams must be above the headwater for the project design flood plus wave runup. Provide minimum training wall downstream of last gate bay.

b. Overflow Dam Plans with Weir 300-, 600-, and 1,200-foot Crest Lengths. These plans provide concrete overflow dam from the last gate pier to the overflow embankment dam. Length of concrete overflow dam is governed by excavation slopes for last spillway gate bay and by the riverward end of the overflow embankment dam. The overflow embankment dam was extended landward so that total length of concrete overflow plus embankment overflow is 300, 600, 1,200 feet, or other selected lengths. Easy vertical transition from overflow embankment to nonoverflow embankment has been provided. For some instances with four, five, and six gate bays, stone will not resist the overflow velocities on the downstream edge of the embankment crown, and a concrete section must be provided. Minimum training wall downstream of last gate bay must be provided.

c. Spillway Gate Piers. The trunnion anchorage elevation can be the same for all gate arrangements since it is related to tailwater.

d. Riprap. Riprap that is needed for each dam arrangement must be provided. A complete layout plan for each dam arrangement must be developed.

e. Top of Lock Walls. The top of lock walls will be eight feet above the normal upper pool for all gate arrangements. This elevation will provide substantially more than two-foot clearance above the headwater for a IO-year flood for all gate arrangements.

f. Stilling Basins and Gated Weirs. The stilling basin will have the same dimensions in an upstream-downstream direction regardless of the number of gates. The gated crests will also have the same dimensions regardless of the number of bays.

3. FLOWAGE EASEMENTS.

a. Some of the spillways would raise flood heights above preproject elevations. Assume that flowage easements are required on all lands above the ordinary high-water line on which flood heights are increased.

b. The channel realignments on this waterway would reduce the overall river length from the mouth of the Black River (1967 mile 34.2) to Shreveport (1967 mile 278) by 48 miles. This shortening will cause a reduction in flood elevations, and the reduction at the Lock and Dam 3 site is estimated to be 2.2 feet. This postproject reduction of 2.2 feet was taken into account when determining whether a given spillway arrangement would raise postproject flood levels above preproject levels. For example, the six-gate, 315-foot-weir spillway would cause a headwater elevation 2.2 feet above postproject tailwater elevation for the project design flood (PDF). However, this spillway would not raise flood heights since the postproject tailwater elevation is estimated to be 2.2 feet below the preproject tailwater elevation.

c. Table D-2 shows how much various spillway arrangements would raise the PDF (248,600 cfs) above preproject level at the damsite and the land acreages on which the PDF would be raised. The calculations showed that the following spillway arrangements would not raise the PDF above preproject conditions.

Number of Gates	Length of Overflow Dam, feet
4	1,510 and longer
5	935 and longer
6	315 and longer
7	0 and longer
8	0 and longer

d. It is proposed to acquire flowage easements up to elevation 98, which is three feet above the navigation pool elevation and one foot above the top of the overflow dam. When a postproject discharge reaches this headwater elevation at the damsite, the water-surface profile upstream will be higher than the flowage easement elevation 98 throughout Pool 3. The postproject discharge will be 178,000 cfs when the headwater elevation at the damsite is 98, and this discharge has an average recurrence interval of about 33 years.

e. The preproject profile for 178,000 cfs was calculated and compared with the postproject profiles for this discharge for the various spillway arrangements. The postproject profiles for the six-, seven-, and eight-bay spillways were equivalent to or lower than the preproject profile. Since the 178,000-cfs discharge would be only about a foot above the top of the overflow dam, the length of overflow dam does not have a significant effect on the headwater elevation. Table D-l shows how much various spillway arrangements would raise the 178,000-cfs discharge above preproject level at the damsite and the land acreages on which this discharge would be raised.

4. LEVEE RAISING. The following spillway arrangements would raise the PDF by a foot or more above preproject and would require raising the flood-control levees adjacent to Pool 3 to provide the preproject level of protection.

Number of Bays	Length of Overflow Dam, feet
4	None
4	300
4	600
4	1,200
5	None
5	300
5	600
6	None

The entire length of this levee would be raised by the amount of height that the postproject PDF is raised above preproject at the mouth of Saline Bayou. The levees would be raised to the same height above the postproject PDF as they were above the preproject PDF.

5. COMPARATIVE COSTS. Detailed cost estimates were calculated for each of the alternative spillway arrangements using October 1982 price levels. These estimates are summarized in Table D-3.

6. CONCLUSIONS AND RECOMMENDATIONS.

a. The alternative consisting of a six-bay spillway and 315-foot overflow dam is the least costly considering all costs and is the selected spillway. The lock and dam structure costs for some of the alternatives were less than for the selected plan, but their costs for additional flowage easements and levee raising caused their total costs to be higher.

b. The recommendations for this site-specific study is to proceed with the alternative consisting of six-bay spillway and 315-foot overflow dam design.

TABLE D-1

Spillway Arrangements That Would Raise 178,000 cfs Above Preproject

Spillway Arrangement		Height of Post-project 178,000 cfs above Pre-project 178,000 cfs at Damsite	Flowage Easements Required on Main Stem	Flowage Easements Required on Tributaries
No. of Bays	Length of Overflow Dam, feet	feet	acres	Approx. acres
4	All	2.0	7,000	6,910
5	All	0.9	7,000	6,910

TABLE D-2

Spillway Arrangements That Would Raise the PDF Above Preproject

Spillway Arrangement		Height of Postproject PDF above Pre-project PDF at Damsite, feet	Flowage Easements Required on Main Stem acres	Flowage Easements Required on Tributaries Approx acres
No. of Bays	Length of Overflow Dam, feet			
4	None	5.3	8,500	6,910
4	300	2.8	8,241	6,910
4	600	2.0	8,147	6,910
4	1,200	0.6	7,000	6,910
5	None	2.4	8,273	6,910
5	300	1.2	7,000	6,910
5	600	0.7	7,000	6,910
6	None	1.0	3,328	3,075
6	300	0.2	--	--

TABLE D-3

Comparative Costs

Spillway Alternative		Lock and Dam Structure costs	Additional Flowage Easement	Levee Raising cost	Total Comparative cost
No. of Bays	Length of Overflow Dam, feet	In Dollars Rounded to Nearest Tenth of a Million			
4	0	157.6	11.6	24.7	193.9
4	300	154.8	11.4	12.1	178.3
4	600	156.5	11.3	8.0	175.8
4	1,200	158.1	10.4	Min	168.5
4	1,510*	158.9	10.4	Min	169.3
5	0	163.8	11.4	10.8	186.0
5	300	162.0	10.4	4.9	177.3
5	600	162.4	10.4	Min	172.8
5	935**	163.3	10.4	0	173.7
5	1,200	164.5	10.4	0	174.9
6	0	170.0	4.8	3.4	178.2
6	300	168.0	0	0	168.0
6	315†	168.0	0	0	168.0
6	600	168.6	0	0	168.6
6	1,200	170.7	0	0	170.7
7	0	176.3	0	0	176.3
7	300	174.3	0	0	174.3
7	600	175.9	0	0	175.9
7	1,200	179.3	0	0	179.3
8	0	183.8	0	0	183.8
8	300	182.3	0	0	182.3
8	600	183.8	0	0	183.8
8	1,200	187.6	0	0	187.6

* Structure costs were extrapolated. This alternative would not raise the PDF.

** Structure costs were interpolated. This alternative would not raise the PDF.

† This is the selected alternative. It would not raise the PDF. The six-bay spillway and 315-foot overflow dam was selected over the six-bay spillway and 300-foot overflow dam because the latter alternative would raise flood heights slightly above preproject conditions. No additional costs were shown in the table for additional flowage easements and levee raising for this slight rise in flood heights because they would be of questionable accuracy. However, the 315-foot overflow dam has the advantage of not raising flood heights, while the 300-foot overflow dam could be difficult to defend since it will raise flood heights to some extent.

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